AMENDMENTS TO THE SPECIFICAITON

Please amend the paragraph beginning at page 7, line 13, as follows:

Referring now to the Drawings, FIGS. 5 through 10 ~~11~~ depict examples of a rotary position sensor according to the present invention.

Please amend the paragraph beginning at page 7, line 15, as follows:

Turning attention firstly to FIGS. 5 through 8 ~~and 11~~, aspects of a first rotary position sensor 200 according to the present invention are depicted. The rotary position sensor 200 includes a magnet assembly 200' supported by a shaft (not shown) having two mutually opposed permanent magnet arcs 16'', 18'', that are glued or bonded into place on an outer flux carrying ring 20''. The permanent magnet arcs are formed from a magnetic material such as for example "bonded," i.e. plastic injection molded, samarium-cobalt Sm_2Co_{17} or $SmCo_5$. Alternatively, the magnet arcs could be formed by sintering. Magnet assembly 200' can also be comprised of magnetic elements such as a ring magnet of unitary construction with two magnetic poles, two individual rectangular or bar magnets separated by a working air gap, etc. For the present embodiment a working air gap 22'' is provided between the permanent magnet arcs 16'', 18'', wherein a nonuniform magnetic field B'' is provided therebetween having a direction indicated by arrowheads D'', locally defined by lines of magnetic flux L'' emanating from the respective permanent magnet poles 26, 28. Referring to FIG. 5, a magnetosensitive

device 24'' having a reference direction indicated by arrow T' is located within the working air gap 22'' of magnet assembly 200'. Furthermore, magnetosensitive device 24'' has a reference point M located at a first selected distance greater than zero mm *X* from the axis of rotation A. The working air gap 22'' is a second selected distance. The reference direction is oriented substantially perpendicular to an imaginary plane passing through the reference point and the axis of rotation. In an exemplary embodiment the first selected distance *X* is about one to about two millimeters (mm), and the second selected distance between the permanent magnet arcs, each having an inner radius of about five mm, is about ten mm. The axis of rotation A is located on imaginary line I between permanent magnet poles 26, 28, at the center C of nonuniform magnetic field B''. Axis of rotation A is not skewed with respect to magnet assembly 200' but rather is substantially parallel to the longitudinal axis (not shown) of the rotary position sensor. For purposes of describing this invention, "parallel" to a given axis or line includes "coincident" with the given axis or line. Magnet assembly 200' is connected to a first article and magnetosensitive sensing element 24'' is connected to a second article, so as to permit measurement of the relative angular displacement between the articles. The first article can be for example a rotating shaft. The second article can be for example a stationary base. However, the second article can also be nonstationary, such as another rotating shaft.

Please amend the paragraph beginning at page 9, line 6, as follows:

The operation of the invention of FIG. 5 is first described with reference to FIG. 11, which is another graph of magnetic field strength B versus angular position for the <u>prior art</u> sensor of FIG. 2, wherein B is shown not to scale for the purpose of illustration. For FIGS. 2

and 11, positive rotation of magnet assembly 14 with respect to magnetosensitive device 24 is now defined as counterclockwise rotation, and produces a positive output signal. Because of its sinusoidal nature, the magnitude of the output signal B in FIG. 11 is attenuated from a desired linear response defined for example by line G tangent to the position sensor's response at 0 degrees. This signal attenuation is exemplified by negative excursion N. Note that line G has a greater slope than that of line J' which passes through the position sensor's output at 0 degrees and ± 45 degrees, similar to line J in FIG. 3. Methods for changing the calibration of a position sensor to accommodate a different slope in the response are known in the art. In order to operate near line G and thereby linearize the output as desired, it is necessary to add a component to the sensor response which is positive, in order to offset the negative excursion at N. This positive offset is supplied in the present invention by a contribution from the signal component due to the magnetosensitive device moving into a region of the magnetic field having a higher flux density. The effect of this can be illustrated for example by a magnetosensitive device centered within a nonuniform magnetic field like that of FIG. 2 and oriented at a selected angle with respect to the magnetic field so as to produce a positive output signal. As the magnetosensitive device is then translated in one direction or the other within the working air gap along an imaginary line perpendicular to the direction of the magnetic field, the output of the magnetosensitive device increases at an approximately exponential rate in the positive direction due to the progressively increasing flux density at the extremities of the nonuniform magnetic field. In other words, a first selected distance greater than zero mm X can be found for the sensor of FIG. 5 at which the increase in output signal due to the increasing flux density optimally offsets the sinusoidal nature of the component due to rotation of the magnetic field about the magnetosensitive device. The sum of these components, in terms of

their respective magnitudes and directions, produces the desired substantially linear response of the present invention. Referring to FIG. 6 as an example of this, magnet assembly 200' has rotated approximately 45 degrees in the positive, i.e. counterclockwise, direction from the zero position. The sensing element 24'' has now effectively been shifted into a region R of the nonuniform magnetic field B'' having a higher flux density than at the zero position. Nonuniform magnetic field B'' is oriented with respect to the sensing element so as to produce a component in the output signal due to the higher flux density which is positive. The component of the output signal due to rotation of magnetic field B'' about the sensing element is sinusoidal in nature, and for positive angular motion produces a negative excursion in the sensing element's output as compared to a desired linear response like G in FIG. 11. According to the present invention, the component of the magnetosensitive device's output signal due to the higher flux density is additive to the component of the output signal due to rotation of the magnetic field about the magnetosensitive device. Therefore the component of the signal due to the higher flux density tends to counteract the sinusoidal nature of the output signal due to rotation of the magnetic field, thereby effectively reducing the deviation from linearity for the response of the position sensor.

Please amend the paragraph beginning at page 12, line 8, as follows:

Referring to FIGS. 9 through <u>10</u> ~~11~~, aspects of another rotary position sensor 300 utilizing a rectangular or bar magnetic circuit according to the present invention are shown. Rotary position sensor 300 includes a magnet assembly 300' supported by a shaft (not shown) having a permanent magnet 316 formed from a magnetic material such as for example sintered Sm_2Co_{17} or $SmCo_5$. Alternatively, the permanent magnet could be formed by plastic injection molding, i.e. "bonded." Magnet assembly 300' further includes a pair of pole pieces 310, 312 composed of ferromagnetic material such as low carbon steel. Each pole piece 310, 312 has a face 320f, 322f which is in good contact with a respective permanent magnet pole 320, 322 of permanent magnet 316, thereby providing minimal reluctance to the magnetic circuit at the interface therebetween. Alternatively, magnet assembly 300' could be made from a single "U-shaped" magnet, with a nonuniform magnetic field provided between the two arms of the "U" such that the arms serve as a substitute for the pair of pole pieces 310, 312. A nonuniform magnetic field B''' is provided within a working air gap 22''' between the pole piece faces 310f, 312f, having a direction indicated by arrowheads D''', and locally defined by lines of magnetic flux L''' emanating from pole piece faces 310f, 312f , respectfully. The magnet assembly 300' is connected to a first article. A magnetosensitive device 24''' having a reference direction indicated by arrow T'' is located within the working air gap 22''' for at least a portion of the sensor's angular range of motion. The magnetosensitive device is connected to a second article so as to permit measurement of the relative angular displacement between the articles. Furthermore, the reference point M' of magnetosensitive device 24''' is located at a first selected distance greater than zero mm *X'* from the axis of rotation A'''. In an exemplary

embodiment the first selected distance *X'* is about one mm to about two mm. The position sensor's axis of rotation A''' is located between magnetosensitive device 24''' and permanent magnet 316 along an imaginary line I', wherein I' is a centerline of permanent magnet 316 that passes through working air gap 22'''. Axis of rotation A''' is not skewed with respect to magnet assembly 300' but rather is substantially parallel to the longitudinal axis (not shown) of the rotary position sensor. For purposes of describing this invention, "parallel" to a given axis or line includes "coincident" with the given axis or line. The reference direction is oriented substantially parallel to an imaginary line passing through the reference point perpendicular to the axis of rotation. The pair of pole pieces 310, 312 are of a geometry such that the magnetosensitive device 24''' can be located between the pole piece faces 310f, 312f. In an exemplary embodiment the distance between the pole piece faces is a second selected distance of about six mm, and the distance between permanent magnet 316 and axis of rotation A''' is a third selected distance of about two mm.